

Seasonal, Thermal, and Zonal Distribution of  
Ocean Sunfish, *Mola mola* (Linnaeus),  
off the North Carolina Coast

DAVID S. LEE

*North Carolina State Museum of Natural History,  
P.O. Box 27647, Raleigh, North Carolina 27611*

**ABSTRACT.**— Most previous information on the ocean sunfish, *Mola mola*, has been derived from beached specimens and contributed little to our understanding of typical distributional patterns of the species. More than 60 encounters with *Mola mola* in North Carolina's offshore waters reveal that this fish is an epipelagic migrant, occurring in shallow water (10 to 40 fathoms in depth) commonly in the spring between mid-March and mid-June. In the fall it has been seen less frequently (mid-October through November), and the species is essentially absent in the winter.

In spite of its cosmopolitan distribution, little information is available concerning the natural history of the ocean sunfish, *Mola mola* (Linnaeus). This is particularly true in the southeastern United States, where nearly all records are of animals found awash in the surf. Because such records may reflect atypical patterns of movement and distribution, observations on the seasonal, thermal, and zonal distribution of *Mola* at sea are of interest. Between 1977 and 1986, I conducted 126 offshore trips for the primary purpose of monitoring seasonal occurrence and abundance of marine birds and mammals. During this period, however, I also incidentally observed other pelagic organisms (see Lee and Booth 1979, Lee and Palmer 1981).

All but seven of the offshore survey trips departed from either Oregon Inlet or Hatteras Inlet, Dare County. Of the seven trips that did not, five were from Beaufort Inlet, Carteret County; one was from Wilmington, New Hanover County; and one was from Virginia Beach, Virginia. Each daylong outing lasted 10 to 11 hours and typically followed predesignated transects of 20 to 55 miles (32 to 88 km) from the point of departure and into the Gulf Stream. All of the Oregon Inlet and Hatteras Inlet surveys extended to at least the 100-fathom contour, and many went several miles beyond the 1,000-fathom contour. Trips were made at all seasons, but monthly coverage was uneven (see Table 1). Ideally, water surface temperature, directional movement, and time and location of sightings were recorded for each sunfish observed. Data are not uniform, however, because some charter boats lacked LORAN and other recording equipment, sea conditions necessitated abbreviated record

Table 1. Seasonal and zonal occurrences of *Mola mola* compared to offshore survey dates and percentage of time spent in each zone.

Month 1977-1986	No. monthly surveys	Depth in fathoms					Other reports	Total no. encountered in month
		1-20	21-40	41-60	61-80	81-100		
January	3	-	-	-	-	-	-	0
February	3	-	-	-	-	-	-	0
March	5	1	1	-	-	-	2	4 (5.8%)
April	11	18	15	1	1	-	1	37 (54.4%)
May	15	6	-	-	1	-	4	11 (16.1%)
June	18	1	1	-	-	2	-	4 (5.8%)
July	15	-	-	-	-	-	-	0
August	19	-	-	-	8	-	-	8 (11.7%)
September	10	-	-	-	-	-	-	0
October	10	-	-	1	-	-	1	2 (2.9%)
November	6	-	1	-	-	-	-	1 (1.4%)
December	11	-	-	-	-	-	1	1 (1.4%)
Approximate percent of survey time in each zone		15%	15%	10%	10%	15%	35%	
Totals	126	26 (43%)	17 (28%)	2 (1%)	10 (16%)	4 (6%)	1 (2%)	68

keeping, and field effort was focused on seabirds. Furthermore, surveys of ocean sunfish from boats are difficult, because surface conditions and angle of view normally limit subsurface visibility. Variations in surface conditions from one trip to another make comparisons of trip-by-trip tallies meaningless. Nevertheless, cumulative records show patterns of zones of occurrence, as well as seasonal movement and abundance.

In the North Atlantic *M. mola* ranges north to the Gulf of St. Lawrence, Newfoundland, southern Iceland, northern Norway, and the Kola Peninsula (Martin and Drewry 1978). It is not common in the tropics (Parin 1968). Information on seasonal movements is mostly conjectural, suggesting passive transport by ocean currents or foraging while following passively drifting coelenterates and ctenophores (see Martin and Drewry 1978). The species is generally regarded as pelagic and solitary, but there are reports of *M. mola* moving in pairs or small groups (Whitley 1931, Smith 1965), and there are several records of summer occurrences, both of free-swimming and surf-washed individuals, in bays such as Sandy Hook, New Jersey (Breder 1932), Isle of Wight Bay, Maryland (Schwartz 1964), and Monterey Bay, California (Myers and Wales 1930).

Records of *Mola* along the southeast coast of North America are scarce, although farther north (e.g., New Jersey; Townsend 1918) it is fairly well established that these headfish occur regularly. Most northern records are of summer encounters. Brimley (1939) documented the occurrence of *M. mola* in North Carolina, providing information on one specimen and three other records; Anderson and Cupka (1973) compiled eight records for South Carolina. The species is known from waters off other southeastern states, including the Gulf of Mexico (Dawson 1965), but generally it appears on state faunal lists with no details of occurrence (e.g., Briggs 1958).

Both *Mola mola* and *Mola* (formerly *Masturus*) *lanceolata* Li-nard, the sharp-tailed mola, are found off the North Carolina coast (Brimley 1939, Funderburg and Eaton 1952). Although Dawson (1965) commented on the difficulty of identifying ocean sunfish at sea, several distinctive field characters separate these two fish. I was able to identify *M. mola* by its dull, nearly uniform color, the rounded dorsal or ventral fins, and the short blunt shape of its tail (which could be confirmed in 70% of sightings). Because nearly all fish seen were considerably greater than 1 meter total length, I assumed most were adults.

Most sunfish were sighted while they were swimming about 0.5 to 1.5 m below the surface. In their "sunning" behavior the fish's sides were always below the surface. Usually the dorsal fin, and occasionally the ventral fin, projected above the surface. Projecting fins were normally held at angles of 45 to 70 degrees and were constantly undulating. This allowed sunfish to be sighted from distances of more than 100 m under calm conditions. Observed fish whose fins did not project above the surface could not be detected for more than 20 to 25 meters from the boat. Normally the fish did not dive at the approach of the boat, but

simply maneuvered out of its way. They sounded only if the boat was on a collision course. Boat captains say the fish are rarely if ever hit by their boats.

Sunfish were seen on calm days, days with considerable swells, and days when small white caps were prevalent, although reduced visibility made comparative counts useless. When seas were quite rough (20+ mph winds, high swells, and extensive white caps), no fish were found; but under these conditions we occasionally sighted marine turtles, sharks, and porpoises. I suspect the sunfish were then swimming deeper, and our failure to see them was not simply a result of the poor subsurface visibility.

Information pooled from 60 sightings of *Mola mola* personally obtained and other available records from the North Carolina coast suggest that the species is not randomly distributed by season or location. Although field effort was not uniform, the records obtained are informative, in that the majority are from areas and seasons having minimal opportunities for observation (see Table 1).

*Season:* *Mola mola* is essentially absent off the North Carolina coast during the winter (see Table 1). Although I have made few winter trips (N = 20), I have no reason to assume ocean sunfish occur regularly at this season, for boat captains and others also have not encountered them in the winter. The earliest spring record is for 16 March, and the earliest fall record is for 17 October. The species is most commonly seen in the spring. Surprisingly, the fish do not occur regularly in our waters during summer. Boat captains say they occasionally see ocean sunfish in the summer, but some of these could be the more tropical *M. lanceolata*. Interestingly, a large part of our survey time during summer was spent in the Gulf Stream, where *M. lanceolata* could be expected, but none was verified. In the summer of 1985 I personally encountered *M. mola* eight times on only 4 of 15 offshore trips, all between 17 and 29 August, a period when relatively calm water usually provides optimum subsurface visibility. No other summer records are available in spite of rather extensive offshore surveys in this season. The fact that only three *M. mola* were encountered in the fall (17 October through 20 November) suggests a different fall migration route, or perhaps a seasonal absence of surface "sunning" behavior. The three dated North Carolina records provided by Brimley (1939) are all for May. Anderson and Cupka (1973) also reported *Mola* from April (2) and May (1); but their other records were from December (2), January (1), and February (2), suggesting winter occurrence in South Carolina (see below).

*Location:* This fish was seldom seen in areas of deep water (> 100 fathoms); most occurred in an offshore zone between 10 and 40 fathoms deep ( $\bar{x}$  = 28.19 fathoms). Most were seen more than 10 miles from shore, although one fish was seen while the survey boat was still in sight of land (19 April 1980). Only six records were in water 40 to 100

fathoms deep, and one December record is from 500 fathoms. Except for the December fish, individuals were not encountered beyond the inner edge of the continental shelf (100 fathoms), although nearly half of our survey time was spent in these deeper waters. Additionally, Charles Manooch, National Marine Fisheries Laboratory, Beaufort, informed me that all of the 15 *Mola* seen by him were between 20 and 30 miles from shore and in water 17 to 25 fathoms deep. Off South Carolina, ocean sunfish (species not determined) have been reported over water about 42 m (23 fathoms) deep (Anderson and Cupka 1973). Interestingly, Lee and Palmer (1980) documented the regular occurrence of leatherback turtles, *Dermochelys coriacea*, another reputed coelenterate feeder, to be restricted, or nearly so, to shallow waters inshore of the 100-fathom contour.

Manooch reported an adult *M. mola* in Core Sound (Harkers Island, fall date not recorded), and the site of Brimley's (1939) Swansboro record is Bogue Sound. Although Myers and Wales (1930) noted that young individuals were of regular occurrence during the summer in Monterey Bay, California, I am not aware of any records from estuarine bays. There are no reports of *Mola*, for example, in the Chesapeake Bay. However, Steve Ross (pers. comm.) captured a single adult from near the mouth (< 20 ppt) of the Neuse River near Long Creek on 16 May 1980 in a gill net. This is the only truly estuarine occurrence of which I am aware.

**Water Temperature:** Ocean surface temperatures were recorded for 20 of my 60 North Carolina sightings at sea, and temperature approximations ( $\pm 2$  °C) are possible for 13 others based on temperatures recorded at other locations near the sighting. The coldest water in which I encountered *M. mola* was 6.8 °C on 16 March 1984, which was also the date of the earliest spring record. The warmest water was 29.4 °C on 13 June 1979, the date of the latest spring sighting. Most encounters were at temperatures between 10 and 18 °C. On all dates a surface temperature gradient was recorded, with coolest waters generally closest to land and warmest waters within the Gulf Stream. Seasonal and thermal distributions (Fig. 1) suggest that, although maximum and minimum temperatures may be critical, these fish are not simply moving into deeper, warmer waters during cool periods, or into cooler inshore waters during warm seasons. Similar findings were reported for several species of marine turtles off the North Carolina coast (Lee and Palmer 1980).

**Time of Day for "Sunning":** Surface "sunning" behavior was noted for most periods of the day, the earliest at 0732 EST and the latest at 1432. Additionally, several sunfish were seen in "mid- to late afternoon," but exact times were not recorded.

**Miscellaneous:** All sunfish observed were solitary, although on several occasions individuals were found within half a mile of each other.

Except for the one December record, none of the *Mola* I saw were known to be associated with jellyfish or other fishes, nor were any associated with sargassum beds, floating boards, or other objects. Manooch (pers. comm.), however, reported diving in water 20 to 30 miles off Beaufort and seeing one *M. mola* associated with a large number of "sea nettle type" jellyfish on 12 March 1976. Probably coelenterates are not easily seen from above the surface. At any rate, none of the coelenterates or ctenophores that could offer a prey base were seen regularly. The only jellyfish typically seen on any of the surveys was *Physalia*, and it invariably was in the Gulf Stream, offshore of the areas inhabited by *Mola*. Likewise ocean sunfish were not found along "tide lines," current edges, sites of local upwellings, or other areas where many marine organisms tend to congregate..

*Migration and Movement:* In that *Mola mola* is well known north of North Carolina in summer and south of the state in winter (Anderson and Cupka 1973) and is rare or absent from North Carolina waters during these periods, most individuals seen off our coast are probably migrants. All spring individuals whose orientation was recorded (about one-half of the total) were swimming north. Their lack of apparent forward movement may be deceptive; when the boat was in motion (10 to 18 knots), the fish appeared to remain in one area. On several occasions, however, sunfish were watched moving past and out of sight of our idling boat (in one case the boat was broken down) in a short time period. As previously implied, movement was within a wide band generally over the 10- to 45-fathom contour.

The records from mid to late August 1985 are interesting in that this was the only summer in 10 years of offshore study that I have seen ocean sunfish. Although late August at first appears early for "fall" migration, I should point out that many southbound sea birds appear in North Carolina offshore waters at this time. Furthermore, various migratory sport fish locally appear or reappear in this same time period. Nevertheless, southward fall migration of *M. mola* would appear to occur primarily in October and November, with movements perhaps starting as early as late August in some years.

Most ocean sunfish were noted between mid-April and mid-May when about 80% of the total sightings were compiled. It may be that south of the Hatteras area migration occurs farther offshore. This is suggested by the few sightings made off Beaufort (5 in 175 trips made by Manooch, pers. comm.; none in 25 trips made by Wayne Irvin, pers. comm., or me). In this area, comparable water zones and the inner edge of the Gulf Stream are much farther from land than off the northern Outer Banks where most of my surveys were conducted.

## DISCUSSION

The ocean sunfish, *Mola mola*, is best regarded as an epipelagic migrant in North Carolina's offshore waters. In the spring it can be

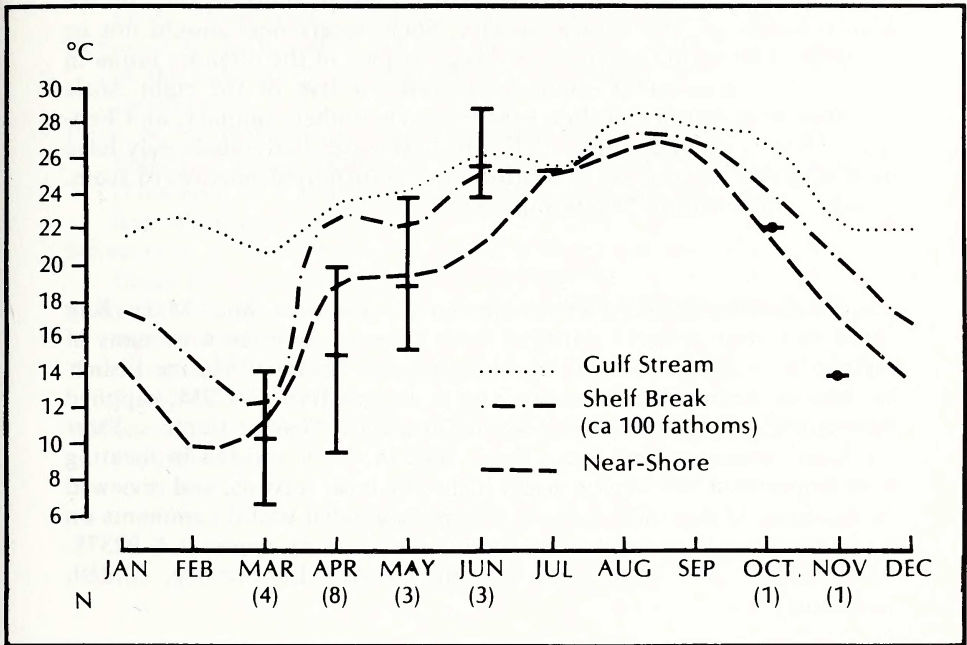


Fig. 1. Thermal distribution of *Mola mola* compared to surface temperature gradients. Ranges and means of temperatures taken in immediate vicinity of *Mola* (N = 20). Average monthly sea-surface temperatures for three areas of the North Carolina continental shelf north of Cape Hatteras (from Newton et al. 1971).

quite common. On 18 and 19 April 1980, 15 were seen each day despite sea surface conditions that offered less than maximum visibility. Five were counted on 14 May 1981, but on all other days only one or two verifiable *M. mola* were seen per trip. Sunfish actually were more common than Table 1 indicates. I often observed two to three times as many individuals as reported, but these sightings were not recorded, either because specific identity could not be confirmed or because other survey priorities were more urgent at the moment.

The dearth of *M. mola* sightings during fall is difficult to explain, especially since Anderson and Cupka (1973) stated that a boat captain reported at least 30 molas (species undetermined) in late autumn of 1970 and 1971 off South Carolina.

Local seasonality of occurrence of *Mola* based on beach stranded specimens may be misleading. Along the Atlantic coast injured, sick, or dead fish could be displaced long distances by the Labrador Current, long shore current, or Gulf Stream. The fact that six of the seven *M. lanceolata* from North Carolina (Brimley 1939, Funderburg and Eaton

1952, NCSM records) are winter records seems contradictory to the known habits of this tropical species. Such occurrences should not be interpreted to mean that they are a regular part of the offshore fauna in winter. The same point could be argued for five of the eight *Mola* reported from South Carolina beaches in December, January, and February (Anderson and Cupka 1973). In both cases individuals may have been numbed by cool sea conditions and transported northward from, to date, undetermined "wintering areas."

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